

WHAT IS CLAIMED IS:

1. A method of producing a semiconductor device, comprising:
    1. sequentially forming an interlayer insulating film and a barrier film on a semiconductor substrate;
    2. making a contact hole in the barrier film and the interlayer insulating film and forming a plug within the contact hole;
    3. forming an insulation film on the plug and the barrier film and then forming a hole leading to the plug in the insulation film such that an upper surface of the plug is exposed;
    4. forming a first conductive film on the insulation film such that the hole is filled with the first conductive film, and then etching the first conductive film by a chemical mechanical polishing method to thereby form a lower electrode within the hole;
    5. etching the insulation film until the barrier film is exposed, so as to leave the lower electrode in a protuberant manner;
    6. forming a dielectric film that covers the protuberant lower electrode and the barrier film, and then forming a second conductive film that covers the dielectric film, said dielectric film being made of a ferroelectric or high-dielectric-constant substance; and

patterning the dielectric film and the second conductive film simultaneously to thereby form a capacitor dielectric film and an upper electrode.

5 2. The method according to claim 1, wherein said barrier film is made of  $TiO_2$  or  $Al_2O_3$  or  $SiN$ .

3. The method according to claim 1, further comprising, after forming the insulation film, forming a  $Ti$  film or a  $TiO_2$  film on the insulation film.

4. A method of producing a semiconductor device, comprising:

sequentially forming an interlayer insulating film and a barrier film on a semiconductor substrate; 15 making a contact hole in the barrier film and the interlayer insulating film and forming a plug within the contact hole;

forming a first insulation film on the plug and 20 the barrier film and then forming a hole leading to the plug in the first insulation film such that an upper surface of the plug is exposed;

forming a first conductive film over the first 25 insulation film and within the hole such that the first conductive film within the hole does not fill the hole but

covers surfaces defining the hole, and then forming a second insulation film on the first conductive film so as to fill the hole;

5 etching the second insulation film until an upper surface of the first conductive film is reached, and then etching the first conductive film and the second insulation film in the hole by a chemical mechanical polishing method until the first insulation film is exposed, to thereby form a cup-shaped lower electrode within the hole;

10 etching the first insulation film and the second insulation film within the hole until the barrier film and the lower electrode are exposed;

15 forming a dielectric film over the cup-shaped lower electrode such that the dielectric film covers inner and outer peripheries and an inner bottom surface of the cup-shaped lower electrode, and then forming a second conductive film that covers the dielectric film, said dielectric film being made of a ferroelectric or high-dielectric-constant substance; and

20 patterning the dielectric film and the second conductive film simultaneously to thereby form a capacitor dielectric film and an upper electrode.

5. The method according to claim 4, wherein said  
25 barrier film is made of  $TiO_2$  or  $Al_2O_3$  or  $SiN$ .

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6. The method according to claim 4, further comprising, after forming the first insulation film, forming a Ti film or a TiO<sub>2</sub> film on the first insulation film.

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7. The method according to claim 4, wherein the second conductive film is formed such that a gap defined between opposite surfaces of the dielectric film within the hole is filled with a part of the second conductive film.

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8. A semiconductor device, comprising:  
an interlayer insulating film formed on a semiconductor substrate;

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a barrier film formed on the interlayer insulating film;  
a contact hole made in the barrier film and the interlayer insulating film;

a plug formed within the contact hole and having a barrier metal buried in an upper portion thereof;

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a cup-shaped lower electrode opening upward, said cup-shaped lower electrode being positioned on the barrier film and the contact hole;

a dielectric film made of a ferroelectric or high-dielectric-constant substance, said dielectric film

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covering inner and outer peripheries and an inner bottom surface of the cup-shaped lower electrode; and  
an upper electrode covering the dielectric film,  
the lower electrode, the dielectric film and the  
5 upper electrode constituting a capacitor.

9. The method according to claim 4, wherein a part of the upper electrode fills a gap defined between opposite surfaces of the dielectric film within the hole.

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